NHS England Carbon Emissions Carbon Footprinting Report

May 2008

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1. Introduction

The NHS has produced an NHS England Carbon Reduction Strategy,[1] as part of a broader sustainable development agenda. To support this process, the Sustainable Development Commission (SDC) has completed a carbon footprinting study - covering all NHS England Estates and activities - in conjunction with the Stockholm Environment Institute (SEI). Appendix A schedules the organisations that currently form NHS England.

This report details the carbon footprinting study, outlining carbon, carbon dioxide (CO_2) and greenhouse gas (GHG) emissions in the three primary sectors (travel, building energy use and procurement) and their sub-sectors. This should help prioritise key action areas in the NHS England Carbon Reduction Strategy.

From the carbon footprinting results, the key headlines are:

- NHS England are responsible for 30% of England public sector emissions
- Procurement of goods and services results in over half (60%) of the emission attributable to NHS England
- The emissions from procurement of pharmaceuticals make up a fifth of those for NHS England, and are comparable to emissions from either building energy use or travel sectors.

2. NHS England carbon footprinting results

The calendar year used for the emissions analysis is 2004, since that is the most recent year for which a full dataset can be obtained. The three main sectors which form the total footprint are:

- **Travel:** Movement of people (i.e. patients, visitors and staff)
- **Building energy use:** Heating, hot water, electricity consumption and cooling
- **Procurement:** Goods and services purchased by NHS England (excluding energy and travel).

The SEI's footprinting methodology essentially takes known total expenditure data reported at a national level via supply-and-use tables by the Office for National Statistics (ONS), and converts this into carbon emissions, and is thus a top-down analysis. As NHS England collates some bottom-up data for building energy use (via the ERIC data collection system), the SEI has replaced the top down building energy data where applicable. Travel emissions are estimated from National Travel Survey (NTS) data, and added to the calculated footprint.

A fuller account of the analytical footprinting methodology and data sources used by the SEI are given in Appendix B.

2.1 Carbon vs CO_2 vs GHG (CO_2e) emissions

When fossil fuels (gas, oil or coal) are burned, they release carbon dioxide (CO_2) into the atmosphere. CO_2 is labelled a GHG as it traps heat in the atmosphere, contributing to a 'greenhouse effect'. Other GHGs include methane and nitrous oxide, and worldwide attempts to mitigate climate change therefore attempt to reduce such GHG emissions. The Kyoto Protocol for example includes six GHGs in its targets.

In the UK, CO_2 emissions account for approximately 85% of the Kyoto GHG emissions, and hence domestic targets focus on curbing CO_2 emissions. Carbon, CO_2 and GHG (measured in CO_2e units) emissions attributable to NHS England are given in Tables 1 and 2. As one mole of CO_2 (which weighs 44g) contains 12g of carbon, the masses of carbon and CO_2 are directly related by the fraction 12/44. CO_2 emissions account for 87% of NHS England GHG emissions, in line with UK emissions. Tables 1 and 2 show the divisions of CO_2 and GHG emissions are very similar between sectors/sub-sectors, and so only CO_2 emissions are given in Figures 1-4. The minor exceptions are in waste and food procurement, which increase emissions due to production / degradation of organic material.

[1] *Saving Carbon, Improving Health* – A draft reduction strategy for the NHS in England. NHS England (2008) www.sdu.nhs.uk

2.2 Consumption vs Production Emissions

NHS England emissions are estimated on a consumption basis, and are the sum of emissions from the consumption of travel, building energy and procurement. Procurement comprises all goods and services purchased by NHS England – which are both from the UK and overseas. This means the emissions estimated are not directly comparable with normally quoted UK emissions, which are reported by the Government on a production basis – i.e. all emissions produced (not consumed) within the geographical UK boundary.

For subsequent comparative purposes (in Section 2.5) between UK and NHS emissions, the UK emissions due to consumption were estimated by the SEI to be 699$MtCO_2$. A fuller derivation is given in Appendix C.

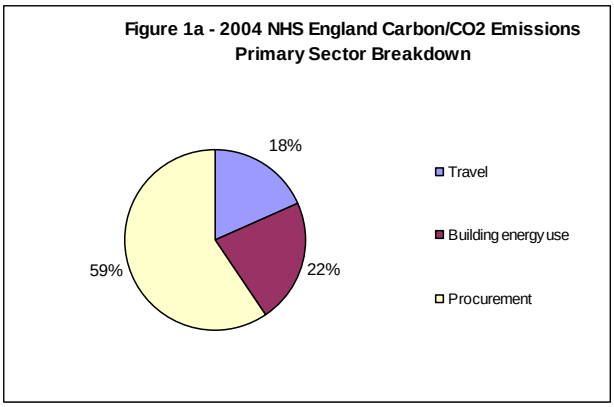
2.3 Primary Sectors

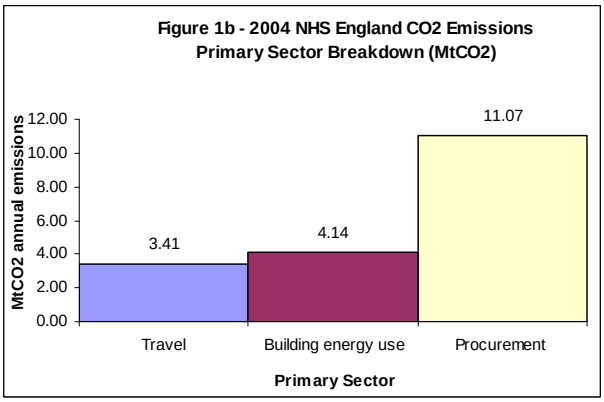
The total NHS England emissions comprise the sum of emissions from three primary sectors: travel, building energy use and procurement. The estimated emissions for these primary sectors and the overall total is given below in Table 1 and Figures 1a and 1b:

Table 1 –2004 NHS England Carbon/CO_2/GHG emissions: Primary sector breakdown

Sector	Carbon emissions		CO_2 emissions		GHG (CO_2e) emissions	
	MtC	% of total	$MtCO_2$	% of total	$MtCO_2e$	% of total
Travel	0.93	18%	3.41	18%	3.45	16%
Building energy use	1.13	22%	4.14	22%	4.59	22%
Procurement	3.02	59%	11.07	59%	13.24	62%
Total	**5.08**	**100%**	**18.61**	**100%**	**21.28**	**100%**

Figures 1a & 1b - 2004 NHS England CO_2 emissions: Primary sector breakdown





2.4 Sub (Secondary) Sectors

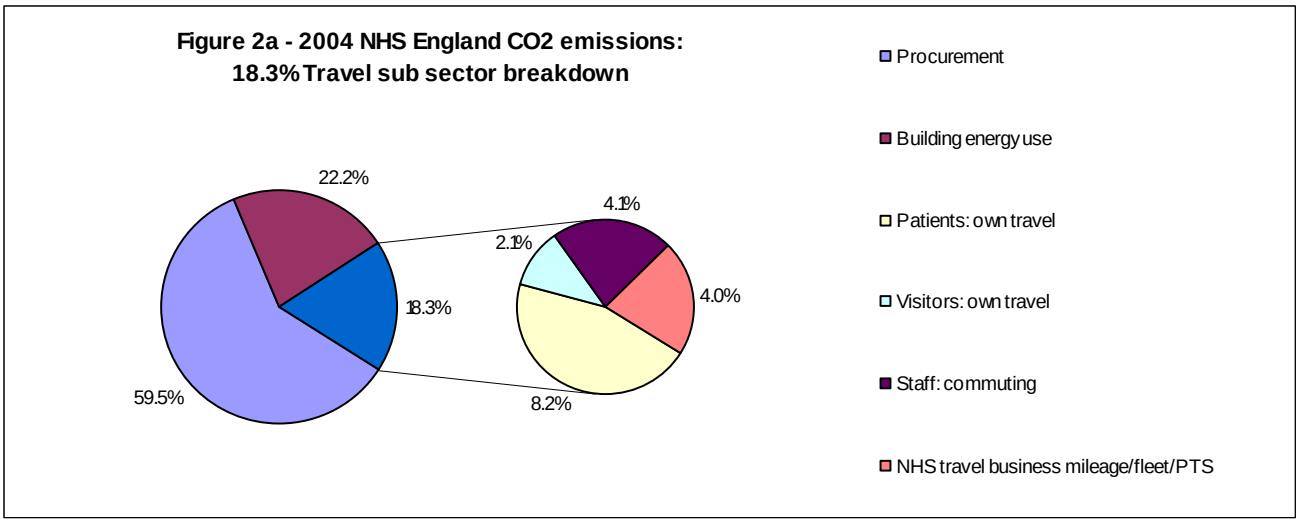
Each of the three primary emissions sectors given above in Section 2.3 have themselves constituent sub-sectors. The estimated emissions for these sub sectors is given below in Table 2 and Figures 2-4:

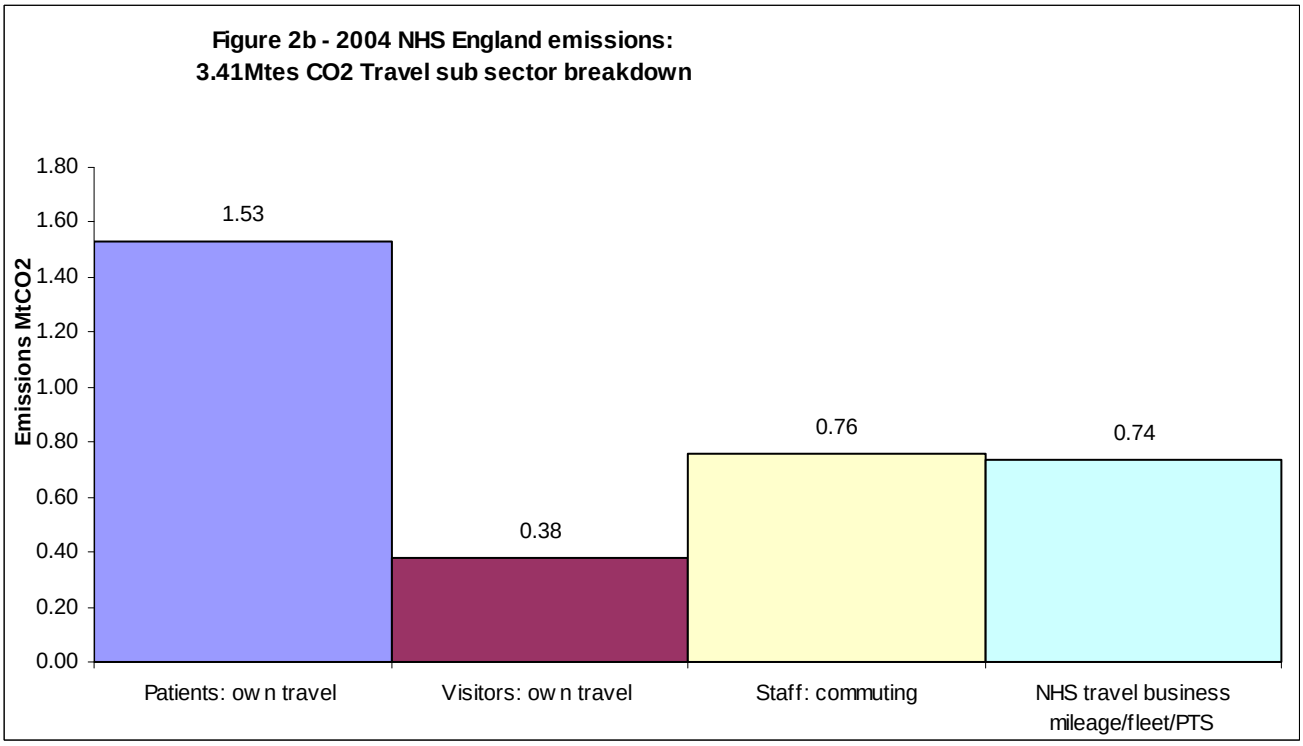
Table 2 – NHS England Carbon/CO_2/GHG emissions in 2004: Sub-sector breakdown

Sector	Sub sector	Carbon emissions		CO_2 emissions		GHG (CO_2e) emissions	
		MtC	% of total	$MtCO_2$	% of total	$MtCO_2e$	% of total
Travel	Patient: own travel[a]	0.42	8%	1.53	8%	1.53	7%
	Visitor travel[a]	0.10	2%	0.38	2%	0.38	2%
	Staff: commuting[a]	0.21	4%	0.76	4%	0.76	4%
	NHS travel: business mileage/fleet/PTS[c]	0.20	4%	0.74	4%	0.78	4%
	Travel: sub total	**0.93**	**18%**	**3.41**	**18%**	**3.45**	**16%**
Building energy use[b]	**Electricity - sub total**	0.63	12%	2.31	12%	2.44	11%
	Heating/hot water - gas	0.45	9%	1.66	9%	1.95	9%
	Heating/hot water – coal	0.02	0%	0.07	0%	0.08	0%
	Heating/hot water - oil	0.03	1%	0.09	1%	0.11	1%
	Heating/hot water - subtotal	0.50	10%	1.83	10%	2.15	10%
	Building energy use: sub total	**1.13**	**22%**	**4.14**	**22%**	**4.59**	**22%**
Procurement[c]	Pharmaceuticals	1.11	22%	4.06	22%	4.57	21%
	Medical Instruments/equipment	0.45	9%	1.66	9%	1.88	9%
	Business services	0.27	5%	0.98	5%	1.12	5%
	Paper products	0.26	5%	0.97	5%	1.03	5%
	NHS Freight transport	0.20	4%	0.72	4%	0.75	4%
	Other manufactured products	0.17	3%	0.63	3%	0.69	3%
	Manufactured fuels/ chemicals/ gases	0.14	3%	0.53	3%	0.59	3%
	Food and Catering	0.11	2%	0.39	2%	0.72	3%
	Construction	0.10	2%	0.36	2%	0.38	2%
	Information and Communication Technologies (ICT)	0.09	2%	0.32	2%	0.36	2%
	Water & Sanitation	0.03	1%	0.13	1%	0.24	1%
	Waste products and recycling	0.03	1%	0.10	1%	0.65	3%
	Other procurement	0.06	1%	0.22	1%	0.26	1%
	Procurement: sub total	**3.02**	**59%**	**11.07**	**59%**	**13.24**	**62%**
Total NHS England emissions		**5.08**	**100%**	**18.61**	**100%**	**21.28**	**100%**

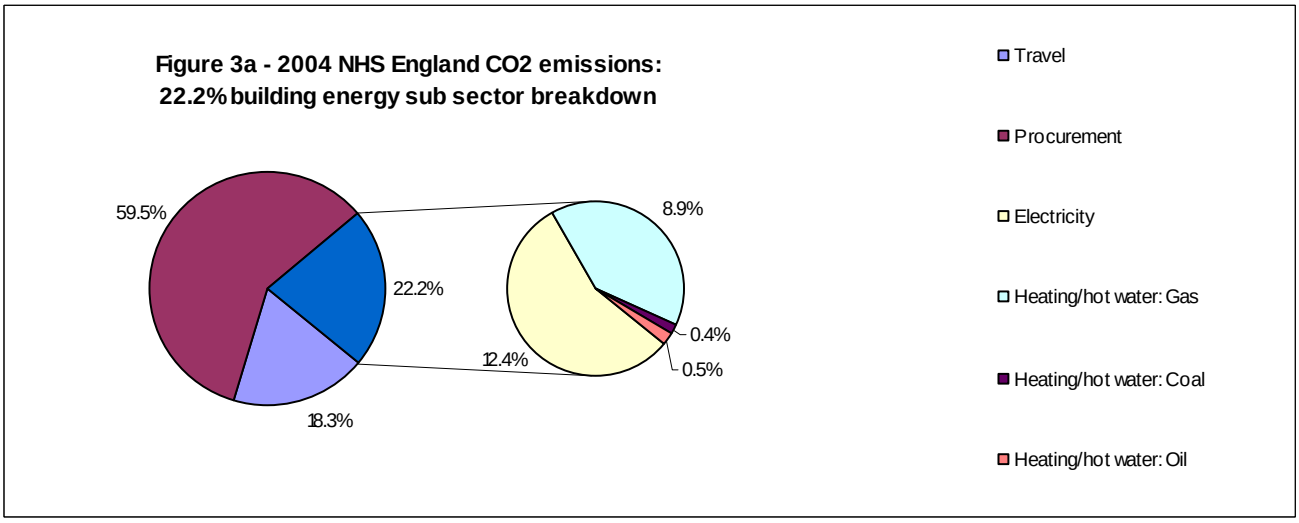
[a] patient/visitor/staff travel estimated from NTS data. NHS travel from ONS data
[b] emissions based on ONS and ERIC energy return data
[c] emissions based on ONS data

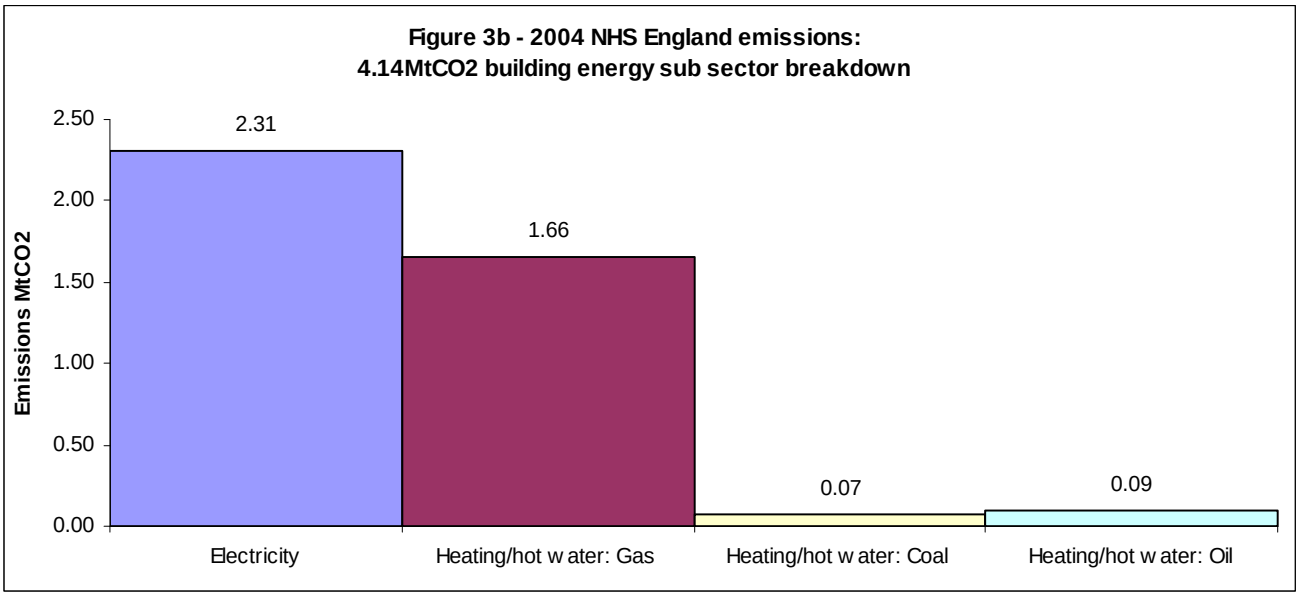
Figures 2a and 2b - 2004 NHS England emissions: Travel Sub-Sector breakdown



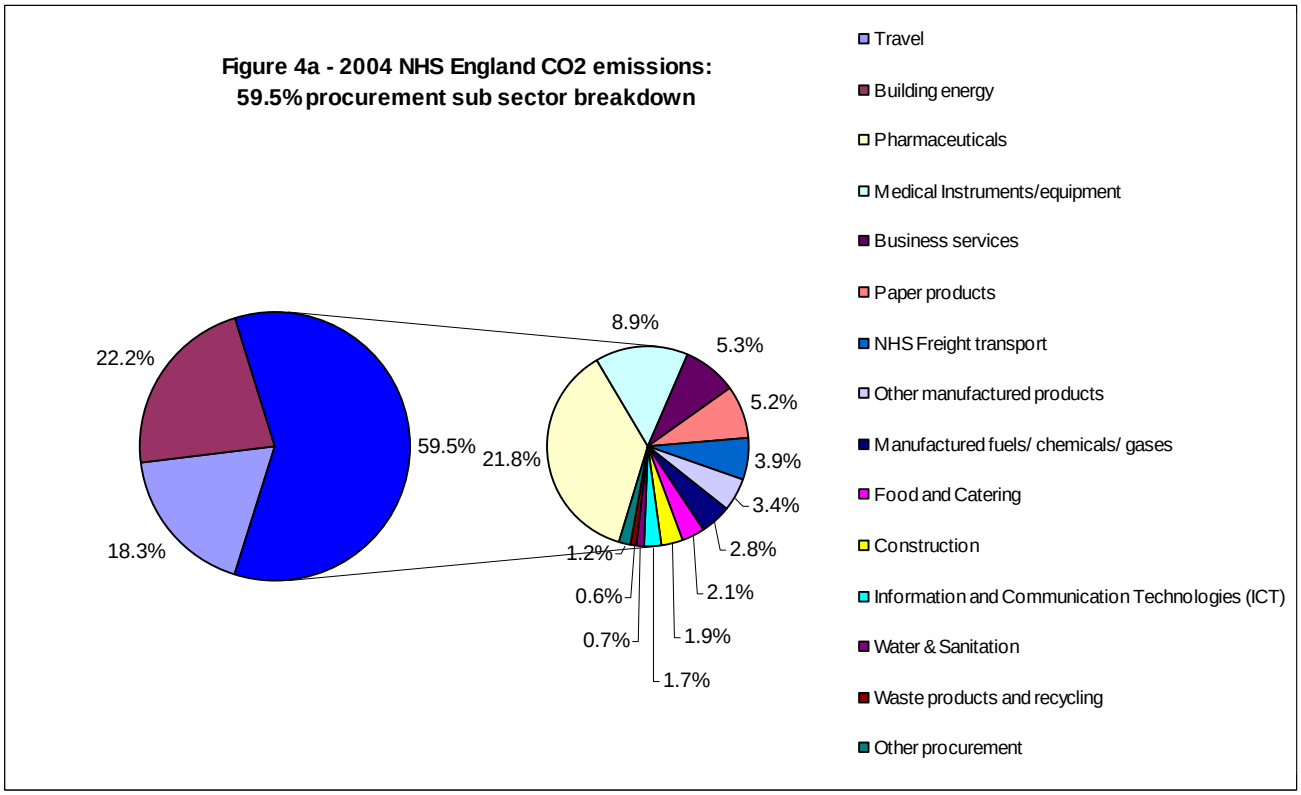


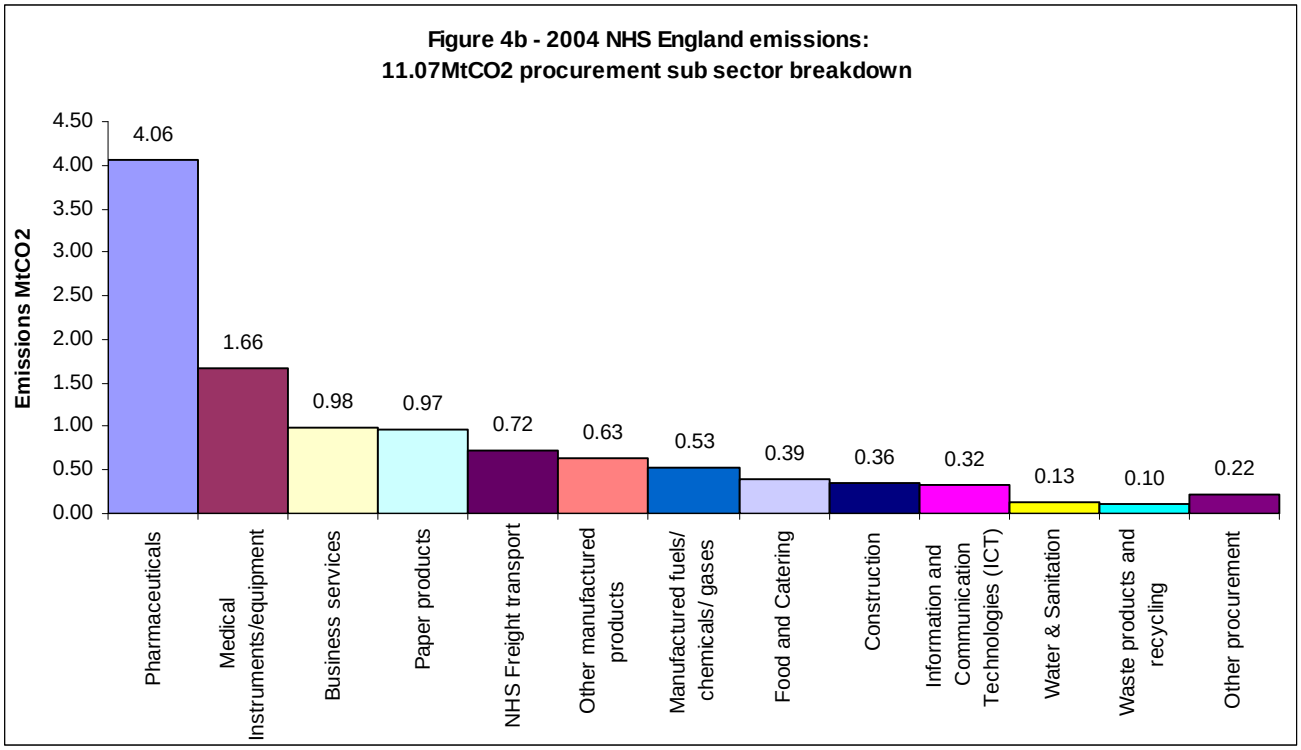
Figures 3a and 3b - 2004 NHS England emissions: Building energy use sub-sector breakdown





Figures 4a and 4b - 2004 NHS England emissions: Procurement sub-sector breakdown





3. Analysis of carbon footprinting results

As UK targets relate primarily to CO_2 emissions, the analysis and discussion of results presented below refer only to CO_2 emissions.

3.1 Total Emissions

Firstly, the total 2004 NHS England CO_2 emissions were estimated to be 18.61MtCO_2. This compares to overall UK and England consumption emissions calculated in the SEI report (Appendix B) as follows:

- 2.7% of total UK emissions (699MtCO_2)
- 3.2% of total England emissions (584MtCO_2)
- 88% of the whole of Northern Ireland emissions (21.3MtCO_2), which has 1.7M inhabitants
- 58% of the whole of Wales emissions (32.0MtCO_2), which has 2.9M inhabitants
- 32% of the whole of Scotland's emissions (58.8MtCO_2), which has 5.1M inhabitants.

Secondly, by removing NHS staff/patient/visitor travel, , the resultant emissions value (18.61-2.67 = 15.94MtCO_2) can be compared to UK and England public sector consumption emissions thus:

- 30% of the whole of the England Public Sector emissions (54MtCO_2).

Thirdly, we can compare the NHS England emissions to these sectors given in Table 4 below, which show that the emissions are broadly in the same range as other UK public sectors:

Table 4: Comparative emissions/expenditure data

Category	Consumption CO_2 emissions ($MtCO_2$)	Net (ie gross – staff costs) Expenditure (£BN)	Emissions ÷ expenditure ($kgCO_2$ / £ spent)
NHS England (2004)	15.94[a]	£29.82BN[b]	0.53
UK Public sector (2001)	62	£120BN[c]	0.53
England Public sector (2001)	54	£100BN[d]	0.54
DCSF schools (2004)	7.70[e]	£17.3BN	0.45

[a] 18.61-2.67(staff commute/patient/visitor travel)
[b] From ONS data: 2004 Government expenditure on health = £76499 million, Expenditure on employees referred to as 'staff compensation' in the IO table = £41073 million. England/UK population = 0.833 (50M/60M), thus 0.833x(76.5-41.1)= £29.82BN
[c] From ONS data: UK government expenditure = £ 250708 million, expenditure on employees = £130777 million, thus 251-131 = £120BN
[d] England/ UK population = 0.833, thus 120*0.833 = £100BN
[e] 8.51MtCO_2 - 0.81MtCO_2(staff commute/pupil travel): Data obtained from SDC (2008).[2]

[2] *Towards a carbon management strategy for the English Schools System*, SDC (2008), unpublished.

3.2 Primary Sector emissions

A key analysis finding is that procurement is the largest NHS England emissions sector. However, this is placed in context by the fact that procurement's proportion of net consumption expenditure was 73% (£22BN / £29.8BN) is very similar to the proportion of net consumption emissions at 69% ($11.07MtCO_2/15.94MtCO_2$).

Both travel and building energy use sectors each provide approximately 20% to the total estimated NHS England CO_2 emissions. The main input data used for the travel analysis has been obtained from NTS survey data. Travel surveys completed on NHS England sites would provide bottom up data which would be invaluable for refining the travel emissions data. Similarly, collation of energy data could be extended to cover all NHS England sites to improve data accuracy.

3.3 Secondary/sub-sector emissions

In the travel sector, the majority (60%) of emissions are those from patients/visitors, with NHS travel (e.g. commuting, business and PTS travel) accounting for the remaining 40% of travel emissions. We define for this report 'travel' to be movement of people, and 'transport' to be of goods and services. Thus transport emissions from goods and services are contained within their sub-sector procurement emissions.

Electricity makes up 55% of overall emissions in the building energy sector, with on-site emissions from heating/hot water consumption forming the other 45%. Gas use is estimated to cause 90% of heating/hot water sub-sector emissions. The bottom up ERIC data used in the calculations of the building energy sector emissions do not include a further breakdown beyond being either electricity or fossil fuel use. A programme of sub metering in NHS England buildings would improve the evidence base, by determining the separate emissions from lighting, IT, heating, hot water etc. This would build on work done by the Building Research Establishment (BRE).[3]

Pharmaceuticals are estimated to provide 37% of the procurement sector emissions, which is equivalent to the whole of the travel or building energy use sectors. Pharmaceuticals in 2004 cost the NHS £10BN (Figure 4.14, OHE Compendium of Health Statistics 2007). Thus as a fraction of procurement expenditure they are estimated to be 38% (£10BN* 0.833 / £22BN = 38%), which is very similar to their proportion of procurement emissions.

Pharmaceuticals and medical equipment together comprise over 50% of procurement sector emissions. The further breakdown of these two procurement sub-sectors was not part of the scope of the carbon emissions study. However, given the size of the overall procurement emissions, it is clear that the carbon reduction strategy would benefit from a more detailed assessment of emissions from the pharmaceuticals and medical equipment sub-sectors.

3.4 Data accuracy

The overall SEI analysis method used is the same as that employed to calculate the overall UK emissions, which was found in Appendix C to be within 2% of the Government's calculated emissions. It can thus be considered a valid methodology for our purposes.

Regarding input data:

- The ONS supply and use tables are the basis of the procurement emissions (60% of total emissions). In addition, the ONS data was initially used as top-down building energy data, which was later checked against bottom-up ERIC data, and found to be almost equal ($4.1MtCO_2$ vs $4.2MtCO_2$). Whilst there is some energy data absent from ERIC (as not all NHS organisations fill in ERIC returns), it is not felt to be significant

[3] eg. BR442 - *Carbon emissions from new non-domestic buildings: 2020 and beyond*, BRE, 2002

- The travel data is the least strong dataset, as this is based solely on national travel survey data which is applied directly for NHS travel, using estimated numbers of visitors, staff and patients. No specific NHS England travel data is available, so whilst emissions are based on estimated data only, it is the smallest of the three sectors (less than 20% of overall emissions).

Certain other data assumptions are made in the analysis. Firstly, NHS data has been multiplied by 0.833 (the fraction of England/UK population) to obtain NHS England results. Secondly, the sector 117 expenditure/emissions (refer to Appendix B) used in the input-output analysis include all health and veterinary services. For the footprinting study it has been conservatively assumed that all such emissions in this category are NHS emissions, though actually a small fraction will be non-NHS.

In summary, there is high confidence in the overall accuracy of the estimated NHS England emissions.

4. Conclusions and Recommendations

The carbon footprinting analysis estimated the carbon, CO_2 and GHG emissions that are the responsibility of NHS England, for the baseline year of 2004. In addition, the contributions of the three primary sectors (travel, building energy use and procurement) have been established, together with their sub-sector emissions. Though some of the input data has limitations, the emissions estimated are considered to be statistically robust and valid for use in the NHS carbon reduction strategy.

The main finding is that procurement forms 60% of emissions for which NHS England are responsible; and within the procurement sector pharmaceuticals are the largest sub-sector, making up 22% of total emissions, which is equivalent to either travel or building energy use emissions. It has also been established that procurement and pharmaceutical emissions are in line with their expenditure profiles.

There are several issues arising from the analysis which could be included within the NHS carbon strategy:

- **Travel plans:** Travel plans (where they exist) are of variable quality and therefore achieve variable results. NHS England as Europe's largest employer has a real opportunity to develop and introduce a standardised approach to travel plans. A well-founded travel plan reduces the carbon footprint, pollution and congestion, whilst encouraging active travel and a healthier population. A good example of a travel plan for a large hospital is Derriford Hospital in Plymouth.
  http://www.dft.gov.uk/pgr/sustainable/travelplans/work/publications/casestudy/plymouthhospitalsnhstrust

- **Pharmaceutical emissions:** Targeting wastage of pharmaceuticals could have a key impact. For example, a 10% reduction in pharmaceuticals consumption would lower overall emissions by 2%. Thus is roughly the same reduction as the 2000-2010 building energy reduction target of 0.15MtC.

- **Building energy sub-metering:** There are already site level studies and projects underway to estimate health facility breakdowns of electricity and heating/hot water energy consumption (eg BRE). The NHS should begin a roll out programme of sub metering of NHS facilities, including the return of sub-metering data via ERIC. This will enable understanding of NHS energy consumption in more detail, which will be essential for future strategy decisions.

Based on the work completed in the initial footprinting study, the following are key recommendations to NHS England to improve input data and provide more useful future output data:

1. The NHS should make mandatory the requirement for building energy use data to be captured via the ERIC system across all NHS England organisations. This will improve the accuracy of the bottom-up building energy data.

2. NHS England should require annual travel surveys to be conducted across its operations. This would be a very useful tool in helping to compare to the National Travel Survey data, and thus provide more accurate input data.

3. A breakdown of key sub-sector emissions (such as pharmaceuticals) should be considered for future emissions analysis. This would help target carbon emissions reductions achievable in the procurement supply chain.

4. The strategy will be considering emissions targets, but there is a need to use emissions scenarios to understand how these targets can be achieved. Firstly a baseline assessment using a Business-As-Usual (BAU) emissions scenario is made, which includes key drivers and their future predicted emissions trends. Secondly, emissions sector analysis can then investigate the cuts required in primary and secondary sub-sectors to achieve the overall emissions reduction targets.

5. Citation and Queries

This report is a joint publication by the SDC and the SEI. Please cite it as SDC-SEI (2008) *NHS England carbon emissions: carbon footprinting study* Sustainable Development Commission, London.

Comments or queries relating to this report should be directed to enquiries@sd-commission.gsi.gov.uk

Appendix A – NHS England

The list below shows the current NHS England organisations:

NHS organisation	No. of		Sub-organisations included
Primary Care Trusts (PCTs)	147	No	NHS Direct NHS Walk in centres NHS GP practices NHS dentists NHS opticians NHS pharmacists
NHS Trusts	235	No	NHS trusts NHS foundation trusts NHS mental health trusts NHS ambulance trusts
Care Trusts	10	No	
Total No of trusts	**392**	**No**	**Trusts**
Strategic Health Authorities	10	No.	North East SHA North West SHA Yorkshire & Humber SHA East Midlands SHA West Midlands SHA East of England SHA London SHA South East Coast SHA South Central SHA South west SHA
Special Health Authorities	10	No.	Health Protection Agency Mental Health Act Commission National Institute For Health and Clinical Excellence National Patient Safety Agency National Treatment Agency NHS Blood and Transplant NHS Business Services Authority NHS Professionals Special Health Authority The Health and Social Care Information Centre The NHS Institute For Innovation and Improvement
Regional Directorates	5	No.	North East Cluster North West & East Midlands Cluster Eastern Cluster Southern Cluster London Cluster
NHS England Does not include	Nursing homes Charities Hospices Private Hospitals		

The carbon footprint of NHS England: an input-output analysis

18.03.2008

Scott, K., Minx, J. and Barrett, J.

The methodological approach

This report measures the carbon footprint of the NHS in England from a *consumption perspective*[4], which seeks to include all carbon emissions associated with the consumption of a particular good or service in the UK, wherever they occur geographically. Emissions produced throughout the industrial supply chain to provide goods and services purchased by the government in order to provide the NHS in England, whether produced in the UK or abroad, are taken into account.

NHS carbon emissions are estimated using a top-down approach complemented with available bottom-up data.

Based on input-output methodology, a top-down approach, we are able to estimate the carbon emissions (carbon dioxide and greenhouse gases) associated with the procurement of goods by the NHS, i.e. embodied emissions of the goods and services consumed by the government in order to provide health services. These include direct and indirect emissions.

Direct emissions occur on-site and are internal to the provision of health services. Indirect emissions occur off-site through the pollution and resource consumption caused in the production of goods and services consumed by the NHS. The sum of these direct and indirect emissions is termed the total emissions.

The majority of carbon impacts are not associated with the direct emissions from heating buildings and driving cars, but with the indirect embodied emissions from products purchased/ consumed. Box 1 illustrates this through the example of purchasing a car. The same principle can be applied to the purchase of medical equipment, pharmaceuticals and so on.

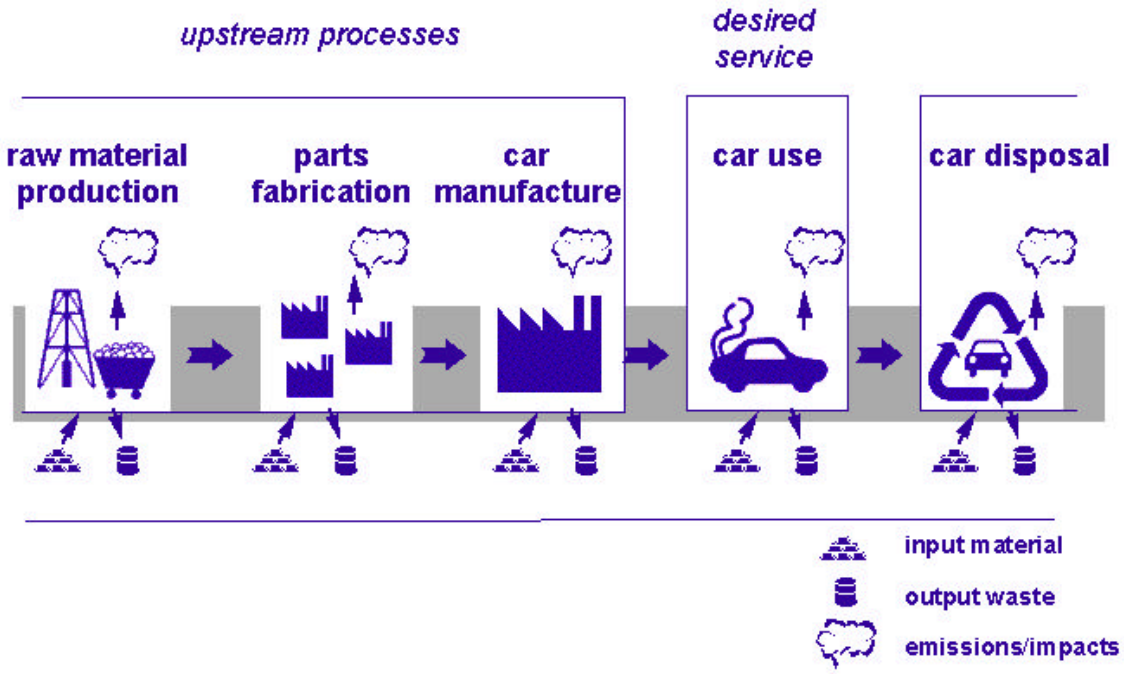
In the past, studies have focused on measuring direct emissions; however, it is vital to measure indirect emissions in order for the NHS to reduce its full carbon impact. This is possible using an input-output approach.

[4] SEI, WWF and CURE, 2006, Counting Consumption. CO_2 Emissions, Material Flows and Ecological Footprint of the UK by Region and Devolved Country, WWF-UK, Surrey.

Box 1: Emissions associated with the purchase of a car

The carbon impacts of a car are not only related to the emissions of driving it, but also to emissions associated with raw material extraction, manufacturing, distribution and disposal of the car.

In the production process there is a hierarchy of production layers, and each one of them needs inputs like materials and energy. The (raw) materials and parts to manufacture the car will be purchased from a range of specialised industries upstream. It is likely that they themselves obtained materials from other industries and so on. The parts of the car are transported downstream to factories in order to put the car together and deliver it to retailers. All these steps use up resources and emit pollution in the process, pollution and resource use that should be accounted for when calculating the emissions associated with purchasing a car.



Once the car is sold to consumers, additional resources are required and pollution is generated when people drive it. Whilst many consider only the emissions released driving a car, this example demonstrates that there are a lot of indirect environmental impacts hidden in the complex combination of production layers, sectors and even countries involved in its fabrication.

In order to provide a carbon footprint of the NHS there are three sources of carbon emissions that need to be measured: direct carbon emissions from buildings, travel carbon emissions, and embodied carbon emissions (Figure 1).

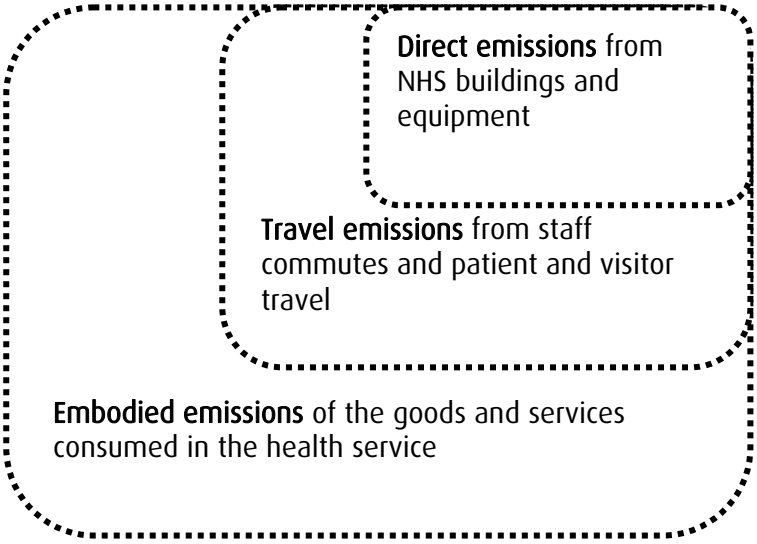


Figure 1: Basic components of carbon footprint of NHS England

Input-output analysis calculates the embodied emissions and building energy emissions[5]. Direct emissions from on-site electricity production are calculated using bottom-up data specific to the NHS[6]. National travel survey data is used to estimate staff, patient and visitor travel, not gained from the input-output analysis. Input-output analysis provides relatively highly aggregated results and provides UK average emissions for industrial sectors.

Table 1 presents the data and data sources required to calculate these emissions.

Emission type	Emission source	Data source
Direct CO_2 emissions	Energy use in NHS buildings	2004 UK input-output table, CO_2 and GHG emissions from UK Environmental Accounts 2004 and ERIC data 2004-5
Travel CO_2 emissions	Direct and indirect emissions from patient, visitor and staff travel to and from health services	National travel survey 2004 and estimates
Embodied CO_2 emissions	Emissions from the procurement of goods and services consumed in the NHS arising in the industrial supply chain	2004 UK input-output table and CO_2 and GHG emissions from UK Environmental Accounts 2004

Table 1: NHS carbon emissions and data sources

[5] This includes electricity supplied from a generation plant, coal, oil, gas, hot water and steam

[6] Estates return information collection 2004/5 provided by the NHS

Calculation of embodied emissions: a top-down approach

For calculating the carbon footprint of the NHS the Resources and Analysis Programme (REAP) developed by the Stockholm Environment Institute has been adapted (Wiedmann and Barrett, 2005)[7]. The relevant part of the REAP tool for estimating the carbon emissions of the NHS is based on an input-output framework, as proposed by Leontief in the 1930s (for a guide to input-output analysis see Miller and Blair, 1985[8]; Leontief, 1970[9]; Leontief, 1986[10]).

Input-output tables describe the flow of goods and services between all the individual sectors of an economy over a stated period of time, commonly a year. The sectors of an economy range from agricultural and manufacturing industries (for example meat production and chemical production) to transport, recreational, health and financial services.

The table describes the monetary transactions occurring between the industrial sectors, value added and final demand categories. Sectors exchange goods and services e.g. steel bought by the vehicle industry or meat bought by the catering industry. There are sales to external purchasers, such as households, the government and foreign trade. Also in producing goods and services sectors pay for other items such as labour, capital and imported goods, known as value added.

Figure 2 shows how an input-output table is presented, with the main component being a transactions matrix of the industrial sectors. Each row of the table indicates the distribution (sale) of an industries output to other domestic industries and to final demand. Each column shows the amounts of inputs purchased from other industries and value added categories.

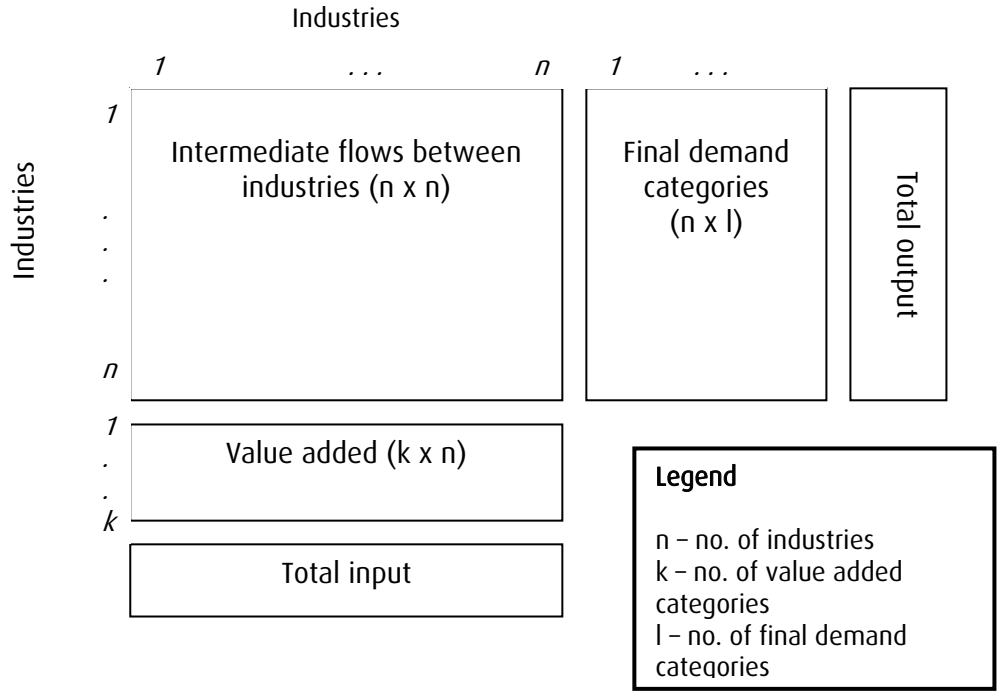


Figure 2: General structure of an input-output table

[7] Wiedmann,T. and Barrett, J. (2005). The use of input-output analysis in REAP to allocate footprints and material flows to final consumption activities, REAP Report No. 2, Stockholm Environment Institute, York, available at www.sei.se/reap.

[8] Miller, R.E. and Blair, P.D. (1985). Input-output analysis: foundations and extensions, New Jersey, Eaglewood cliffs.

[9] Leontief, W (1970), taken from Kurz, H.D., Dietzenbacher, E. And Lager, C (1998), Input-output analysis Volume II, Cheltenham, Edward Elgar Publishing Lt.

[10] Leontief, W (1986), Input-output economics, New York, Oxford University Press.

Initially developed to analyse the interdependencies of industries in an economy, input-output analysis has since been extended to account for environmental impacts, such as pollution and resource consumption. If you have energy use or pollution emitted by industrial sector (in physical units), it is possible to calculate the direct and indirect environmental impacts of the consumption of goods and services by final demand.

Based on the assumption that each unit of a sector's product or service delivered to other production sectors or final consumers produces the same amount of pollution (for example carbon dioxide) per unit of sectoral output, sectoral carbon dioxide intensities (expressed in tons of carbon dioxide per unit of sectoral output) can be calculated and used for the estimation of all carbon emissions triggered throughout the supply chain by final demand as recorded in the input-output tables.

For the analysis of the NHS, a 2004 UK input-output table comprising of 178 industrial sectors and five final demand categories is used, provided by SEI[11,12], along with corresponding carbon dioxide and greenhouse gas emissions provided by National Statistics Environmental Accounts.

The sector of focus in this study is termed 'human health and veterinary activities' (sector 168 in the input-output table[13]). There is not a sector assigned to the NHS alone, and aggregation of sectors is a limitation of such an approach.

The input-output table indicates the purchases of the health and veterinary activities sector from other sectors, and the sectoral output of the health sector to final demand, in which government is of relevance for this study. Government spending on the health sector is taken as a representation of NHS activities at this stage. Whilst this spending could include spending by the department of health, for example, it is likely that by far the majority will be NHS expenditure.

As input-output analysis is a top-down approach and therefore calculates UK industry averages, a comparison of the energy use emissions generated by the input-output analysis and bottom-up data specific to NHS operations from ERIC data (provided by the NHS) has been carried out. The results are found to be similar, with a difference of approximately 0.1 Mt CO_2. There is scope to reconcile this data.

Figure 3 represents the data used for the carbon analysis of the NHS (an extended environmental input-output table adapted to the requirements of this project). NHS related expenditures are found in two parts of input-output tables:

- Purchases by the health sector of goods and services from other industrial sectors (the vertical red dotted line in figure 3)
- Government expenditure on the health sector in the final demand section (where the blue dashed line meets the horizontal red dotted line in figure 3). It has been assumed that the proportion of spending in England compared with the UK is 50/60, according to the population fraction.

[11] Wiedmann, T., Wood, R., Lenzen, M., Minx, J., Guan, D. and Barrett, J. (2007) Development of an Embedded Carbon Emissions Indicator – Producing a Time Series of Input-Output Tables and Embedded Carbon Dioxide Emissions for the UK by Using a MRIO Data Optimisation System, Report to the UK Department for Environment, Food and Rural Affairs by Stockholm Environment Institute at the University of York and Centre for Integrated Sustainability Analysis at the University of Sydney. Defra, London, UK (not yet published). Available only for 1995 at the 76 sector level from ONS.

[12] Only available in supply and use table format for 2004 at 123 sector level from the Office for National Statistics.

[13] This is sector 117 in the supply and use tables of the Office for National Statistics

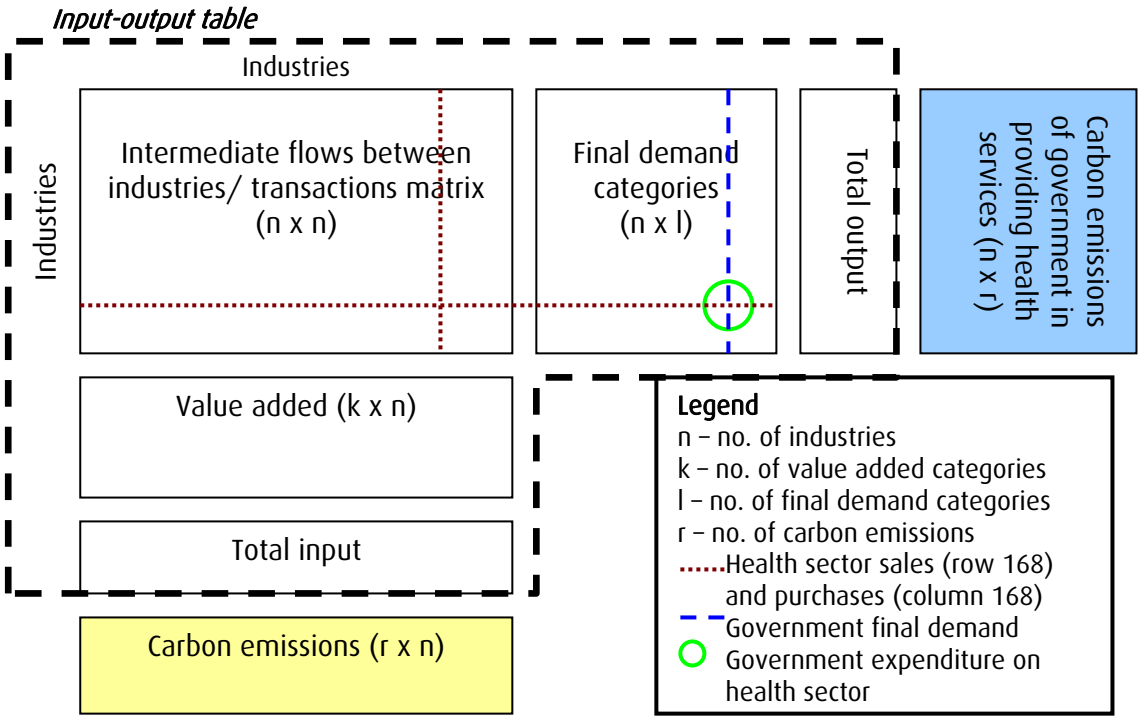


Figure 3: General structure of the environmental input-output table of the NHS

The emissions calculated represent the total English emissions from government spending on the health and veterinary sector (the blue box in figure 3). See Appendix 1 for full results. The emissions from 178 sectors can be aggregated into 3 main categories: travel, building energy and procurement, as shown in the table below:

Main sector	Sub sector	178 industrial sector numbers
Procurement	Pharmaceuticals	68
	Medical Instruments/equipment	103
	Business services	130, 144, 146-151, 157-163, 177
	Paper products	50-54
	NHS Freight transport	133, 137, 138, 140, 142, 143
	Other manufactured products	42, 44, 46, 48, 71-76, 87-88, 108, 111.
	Manufactured fuels/ chemicals/ gases	13, 56, 58-60, 69, 70
	Food and Catering	1-7, 19-35, 131
	Construction	77-79, 84, 122-124
	Information and Communication Technologies (ICT)	55, 96, 145, 154, 156
	Water & Sanitation	121, 170, 173
	Waste products and recycling	112, 113, 171-172
	Other procurement (includes industrial sectors which have zero emissions)	8-12, 14-18, 36-41, 43, 45, 47, 49, 61-67, 80-83, 85-86, 89-95, 97-102, 105, 107, 109-110, 127-129, 153, 155, 164-167, 169, 174-176, 178
Building energy	Heating/hot water and Electricity (later allocated to sub-sectors in proportions of ERIC data)	114-120, 168
Travel	NHS travel	57, 104, 106, 125-126, 132, 134-136, 139, 141, 152

Table 2: Allocation of 178 sectors into three primary sectors and sub-sectors (see Appendix 1 for classification of sectors)

Travel emissions

Travel emissions from staff commutes, and patient and visitor travel to NHS facilities are not included in the input-output analysis, as these expenditures are attributed to household final demand, not government spending. However, they form an important part of the carbon footprint of the NHS. Travel emissions have been estimated using data from the 2004 National Travel Survey.

The estimated distance travelled to and from NHS services by staff, patients and visitors, is calculated in kilometres, and multiplied by conversion factors provided by SEI REAP. Conversion factors are the carbon emissions produced per unit of output, in this case kg CO2 per km. Appendix 2 shows how these estimations are calculated.

These are added to the top-down data on NHS travel.

Direct emissions: a bottom-up approach

Specific information regarding the energy use of NHS buildings is available from ERIC data (Estates Return Information Collection). This gives the electricity, gas, oil, coal hot water and steam use in GJ (which are converted into kWh) of the NHS in England. These are multiplied by conversion factors provided by DEFRA[14]. The conversion factors are in kg CO2 per kWh. For steam and hot water we have assumed gas as the energy source, which is the fuel with the lowest carbon impact. This may lead to a slight underestimation of emissions. Appendix 3 shows how these estimations are calculated.

The results are compared with the data generated by the input-output analysis and are found to be similar, with approximately a difference of 0.1 Mt CO_2. From the input-output analysis, one figure is given for emissions from on-site energy use by the NHS[15]. This is disaggregated between coal, oil and gas according to NHS energy mix, obtained from ERIC data (see Appendix 4).

On-site electricity generation at NHS facilities is added onto the energy use emissions, as this is not generated in the input-output analysis as there will have been no monetary transactions reflected in the input-output table.

Comparative CO_2 emissions

To facilitate direct comparisons between the CO_2 emissions for NHS England against other sectors, it is necessary to calculate equivalent consumption (rather than production) emissions. Total consumption emissions for the different regions of the UK are taken from REAP, as are total emissions from government spending only. These are shown in Appendix 5.

[14] DEFRA (2005). Guidelines for company reporting on Greenhouse gas emissions, available at http://www.defra.gov.uk/environment/business/envrp/pdf/envrpgas-annexes.pdf.

[15] This is the energy from coal, oil and gas, which are burned on-site, as opposed to electricity which is generated externally and distributed to buildings

Appendix 1: Total emissions of the NHS supply chain from 178 sectors

Sources: Input-output analysis of the NHS, using a 2004 UK input-output table comprising of 178 industrial sectors and five final demand categories is used, provided by SEI[16], along with corresponding carbon dioxide and greenhouse gas emissions provided by National Statistics Environmental Accounts.

	Industries (NACE)	Government expenditure on health - England (£ million)	Emissions intensity/ impact (kg/ £ spent)		NACE industry emissions (kt)	
			CO2	GHG	CO2	GHG
1	Conventional Growing of cereals, vegetables, fruits and other crops	11.03	0.36	1.59	3.98	17.54
2	Organic Growing of cereals, vegetables, fruits and other crops	0.22	0.61	2.07	0.13	0.45
3	Growing of horticulture specialities and nursery products	1.70	0.44	1.74	0.74	2.96
4	Conventional Farming of livestock (except poultry)	16.82	0.36	1.59	6.09	26.79
5	Organic Farming of livestock (except poultry)	0.17	0.61	2.07	0.11	0.36
6	Conventional Farming of poultry	3.12	0.39	1.66	1.23	5.17
7	Organic Farming of poultry	0.03	0.62	2.09	0.02	0.07
8	Forestry, logging and related service activities (conventional)	0.00	0.00	0.00	0.00	0.00
9	Forestry and logging and related service activities ('sustainable' / FSC)	0.00	0.00	0.00	0.00	0.00
10	Fishing	0.00	0.00	0.00	0.00	0.00
11	Fish farming (non-organic)	0.00	0.00	0.00	0.00	0.00
12	Fish farming (organic/sustainable)	0.00	0.00	0.00	0.00	0.00
13	Mining of coal and lignite; extraction of peat	3.68	0.45	3.18	1.64	11.69
14	Extraction of crude petroleum and natural gas and Service activities incidental to oil and gas extraction, excluding surveying	0.00	0.00	0.00	0.00	0.00
15	Mining of uranium and thorium ores	0.00	0.00	0.00	0.00	0.00
16	Mining of iron ores	0.00	0.00	0.00	0.00	0.00
17	Mining of non-ferrous metal ores, except uranium and thorium ores	0.00	0.00	0.00	0.00	0.00
18	Mining and quarrying of stone, gravel, clays, salt, etc.	0.00	0.00	0.00	0.00	0.00
19	Conventional meat and meat products (excl. poultry)	119.58	0.36	0.77	42.75	91.53
20	Organic meat and meat products (excl. poultry)	6.32	0.46	1.02	2.90	6.47
21	Conventional poultry meat and poultry meat products	73.33	0.36	0.78	26.48	56.84
22	Organic poultry meat and poultry meat products	1.18	0.46	1.03	0.55	1.22

[16] Wiedmann, T., Wood, R., Lenzen, M., Minx, J., Guan, D. and Barrett, J. (2007) Development of an Embedded Carbon Emissions Indicator – Producing a Time Series of Input-Output Tables and Embedded Carbon Dioxide Emissions for the UK by Using a MRIO Data Optimisation System, Report to the UK Department for Environment, Food and Rural Affairs by Stockholm Environment Institute at the University of York and Centre for Integrated Sustainability Analysis at the University of Sydney. Defra, London, UK (not yet published). Available only for 1995 at the 76 sector level from ONS.

23	Fish and fish products	35.44	0.33	0.58	11.70	20.48
24	Conventional Fruit and vegetables	61.40	0.31	0.53	18.93	32.75
25	Organic Fruit and vegetables	17.16	0.45	0.82	7.73	14.06
26	Vegetable and animal oils and fats	9.19	0.47	0.66	4.36	6.07
27	Dairy products (conventional)	106.45	0.36	0.92	38.85	98.22
28	Organic dairy products	7.55	0.45	1.21	3.42	9.14
29	Grain mill products, starches and starch products	29.42	0.32	0.67	9.43	19.74
30	Prepared animal feeds	5.52	0.36	0.67	1.97	3.72
31	Bread, rusks and biscuits; manufacture of pastry goods and cakes (conventional)	90.45	0.26	0.35	23.35	31.80
32	Organic bread, rusks and biscuits; manufacture of pastry goods and cakes	21.70	1.19	2.29	25.88	49.75
33	Sugar	9.19	0.36	0.80	3.30	7.38
34	Cocoa, chocolate and sugar confectionery	114.00	0.24	0.32	26.92	35.93
35	Other food products	64.35	0.30	0.49	19.55	31.56
36	Alcoholic beverages	0.00	0.00	0.00	0.00	0.00
37	Production of mineral waters and soft drinks	0.00	0.00	0.00	0.00	0.00
38	Tobacco products	0.00	0.00	0.00	0.00	0.00
39	Preparation and spinning of textile fibres	0.00	0.00	0.00	0.00	0.00
40	Textile weaving	0.00	0.00	0.00	0.00	0.00
41	Finishing of textiles	0.00	0.00	0.00	0.00	0.00
42	Made-up textile articles, except apparel	97.45	0.44	0.47	42.64	45.37
43	Carpets and rugs	0.00	0.00	0.00	0.00	0.00
44	Other textiles	115.83	0.48	0.52	55.65	59.79
45	Knitted and crocheted fabrics and articles	0.00	0.00	0.00	0.00	0.00
46	Wearing apparel; dressing and dying of fur	463.34	0.28	0.31	130.19	141.43
47	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery and harness	0.00	0.00	0.00	0.00	0.00
48	Footwear	12.87	0.20	0.24	2.60	3.11
49	Wood and wood products, except furniture	0.00	0.00	0.00	0.00	0.00
50	Pulp	1.23	1.29	1.37	1.60	1.69
51	Paper and paperboard	302.14	1.18	1.25	356.11	377.63
52	Articles of paper and paperboard (except paper stationary)	647.37	0.55	0.60	358.13	386.62
53	Paper stationary	58.67	0.63	0.68	36.95	39.61
54	Paper-based publishing, printing and reproduction	850.08	0.25	0.27	212.77	228.92
55	Non paper-based publishing and reproduction of recorded media	30.63	0.32	0.34	9.70	10.42
56	Coke oven products	0.27	33.65	35.40	9.06	9.53
57	Refined petroleum products	342.82	0.91	0.94	310.42	322.53
58	Processing of nuclear fuel	15.45	0.44	0.48	6.83	7.38
59	Industrial gases	69.44	0.87	0.93	60.27	64.71
60	Dyes and pigments	105.23	0.87	0.93	91.27	98.00
61	Inorganic basic chemicals	0.00	0.00	0.00	0.00	0.00
62	Organic basic chemicals	0.00	0.00	0.00	0.00	0.00
63	Fertilisers and nitrogen compounds	0.00	0.00	0.00	0.00	0.00

64	Plastics and synthetic rubber in primary forms (non-PVC)	0.00	0.00	0.00	0.00	0.00
65	PVC plastics in primary forms	0.00	0.00	0.00	0.00	0.00
66	Pesticides and other agro-chemical products	0.00	0.00	0.00	0.00	0.00
67	Paints, varnishes and similar coatings, printing ink and mastics	0.00	0.00	0.00	0.00	0.00
68	Pharmaceuticals, medicinal chemicals and botanical products	16,792.31	0.24	0.27	4,056.26	4,571.68
69	Soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations	292.34	0.38	0.42	111.38	122.92
70	Other chemical products	601.24	0.41	0.46	246.34	277.79
71	Man-made fibres	27.58	0.83	0.90	22.96	24.84
72	Rubber products	38.61	0.38	0.44	14.52	17.05
73	Plastic plates, sheets, tubes and profiles	330.98	0.42	0.47	138.83	156.89
74	Plastic packing goods	69.85	0.41	0.46	28.62	32.32
75	Glass and glass products	27.58	0.64	0.68	17.77	18.85
76	Ceramic goods	44.13	0.40	0.43	17.66	19.15
77	Bricks, tiles and other structural clay products for construction	27.58	0.72	0.77	19.87	21.36
78	Cement, lime and plaster	27.58	5.33	5.50	147.10	151.59
79	Articles of concrete, plaster and cement; cutting, shaping and finishing of stone; manufacture of other non-metallic products	40.45	0.62	0.65	24.92	26.37
80	Basic iron and steel and of ferro-alloys; manufacture of tubes and other first processing of iron and steel	0.00	0.00	0.00	0.00	0.00
81	Copper, Lead, Zinc, Tin and other basic precious and non-ferrous metals (not Aluminium)	0.00	0.00	0.00	0.00	0.00
82	Aluminium	0.00	0.00	0.00	0.00	0.00
83	Casting of metals	0.00	0.00	0.00	0.00	0.00
84	Structural metal products	31.26	0.56	0.59	17.53	18.49
85	Tanks, reservoirs and containers of metal; manufacture of central heating radiators and boilers; manufacture of steam generators	0.00	0.00	0.00	0.00	0.00
86	Forging, pressing, stamping and roll forming of metal; powder metallurgy; treatment and coating of metals	0.00	0.00	0.00	0.00	0.00
87	Cutlery, tools and general hardware	71.71	0.35	0.37	25.02	26.80
88	Other fabricated metal products	53.32	0.48	0.52	25.85	27.57
89	Machinery for the production and use of mechanical power, except aircraft, vehicle and cycle engines	0.00	0.00	0.00	0.00	0.00
90	Other general purpose machinery	0.00	0.00	0.00	0.00	0.00
91	Agricultural and forestry machinery	0.00	0.00	0.00	0.00	0.00
92	Machine tools	0.00	0.00	0.00	0.00	0.00
93	Other special purpose machinery	0.00	0.00	0.00	0.00	0.00
94	Weapons and ammunition	0.00	0.00	0.00	0.00	0.00
95	Domestic appliances (e.g. white goods)	0.00	0.00	0.00	0.00	0.00
96	Computers and other office machinery and equipment	446.79	0.21	0.23	94.52	104.92

97	Electric motors, generators and transformers; manufacture of electricity distribution and control apparatus	0.00	0.00	0.00	0.00	0.00
98	Insulated wire and cable	0.00	0.00	0.00	0.00	0.00
99	Electrical equipment not elsewhere classified	0.00	0.00	0.00	0.00	0.00
100	Electronic valves and tubes and other electronic components	0.00	0.00	0.00	0.00	0.00
101	Television and radio transmitters and line for telephony and line telegraphy	0.00	0.00	0.00	0.00	0.00
102	Television and radio receivers, sound or video recording or reproducing apparatus and associated goods	0.00	0.00	0.00	0.00	0.00
103	Medical, precision and optical instruments, watches and clocks	8,316.17	0.20	0.23	1,663.77	1,876.97
104	Motor vehicles, trailers and semi-trailers	11.03	0.36	0.39	3.94	4.27
105	Building and repairing of ships and boats	0.00	0.00	0.00	0.00	0.00
106	Railway transport equipment, motorcycles, bicycles and transport equipment n.e.c.	288.67	0.30	0.32	85.71	91.84
107	Aircraft and spacecraft	0.00	0.00	0.00	0.00	0.00
108	Furniture	216.96	0.38	0.41	82.70	88.54
109	Jewellery and related articles; manufacture of musical instruments	0.00	0.00	0.00	0.00	0.00
110	Sports goods, games and toys	0.00	0.00	0.00	0.00	0.00
111	Miscellaneous manufacturing not elsewhere classified; recycling	71.53	0.38	0.41	27.06	29.54
112	Recycling of metal waste and scrap	24.31	0.46	0.50	11.15	12.17
113	Recycling of non-metal waste	32.87	0.43	0.47	14.17	15.46
114	Electricity production - gas	179.53	4.23	4.48	760.22	805.10
115	Electricity production - coal	212.34	5.63	5.87	1,195.61	1,246.66
116	Electricity production - nuclear	126.92	1.18	1.38	149.87	175.13
117	Electricity production - oil	7.33	1.65	1.93	12.06	14.12
118	Electricity production - renewables (and other)	23.64	4.40	4.72	104.09	111.48
119	Gas distribution	411.27	1.05	1.32	433.44	542.57
120	Steam and hot water supply	4.26	0.73	0.94	3.10	4.00
121	Collection, purification and distribution of water	145.25	0.24	0.26	34.31	37.14
122	Construction (other than commercial and domestic buildings)	127.03	0.19	0.20	23.76	25.97
123	Construction of commercial buildings	405.19	0.21	0.22	83.09	90.75
124	Construction of domestic buildings	230.82	0.19	0.21	44.99	49.15
125	Sale, maintenance and repair of motor vehicles, and motor cycles; retail sale of automotive fuel	113.91	0.18	0.20	20.41	22.52
126	Retail sale of automotive fuel	14.79	0.19	0.20	2.74	3.03
127	Wholesale trade and commission trade, except of motor vehicles and motor cycles	0.00	0.00	0.00	0.00	0.00
128	Retail trade, except of motor vehicles and motor cycles	0.00	0.00	0.00	0.00	0.00
129	Repair of personal and household goods	0.00	0.00	0.00	0.00	0.00
130	Hotels and accommodation	195.51	0.17	0.22	32.37	43.75

131	Restaurants, cafes, bars etc.	679.68	0.17	0.23	114.54	154.57
132	Passenger transport by railways	132.02	0.28	0.31	37.31	41.30
133	Freight transport by inter-urban railways	59.20	0.29	0.32	17.00	18.81
134	Buses and coaches	48.04	1.98	2.04	94.94	98.03
135	Tubes and Trams	325.59	0.19	0.20	60.95	66.51
136	Taxis operation	48.83	0.98	1.04	47.64	50.69
137	Freight transport by road	1,219.90	0.49	0.51	599.35	622.97
138	Transport via pipeline	6.90	0.41	0.43	2.83	2.97
139	Passenger sea and coastal water transport + Passenger inland water transport	0.14	1.69	1.73	0.24	0.25
140	Freight sea and coastal water transport + Other inland water transport	18.24	1.68	1.72	30.68	31.43
141	Passenger air transport	1.56	1.52	1.56	2.37	2.42
142	Freight and other air transport	42.57	1.45	1.48	61.59	62.90
143	Supporting and auxiliary transport activities: travel agencies, cargo handling, storage, etc.	64.35	0.12	0.13	7.84	8.69
144	Postal and courier services	305.21	0.17	0.19	51.40	56.57
145	Telecommunications	899.10	0.13	0.14	113.56	126.35
146	Banking and financial intermediation, except insurance and pension funding	27.58	0.14	0.16	3.99	4.40
147	Insurance and pension funding, except compulsory social security	774.07	0.13	0.14	100.02	110.46
148	Auxiliary financial services	0.00	0.00	0.00	0.00	0.00
149	Real estate activities with own property; letting of own property, except dwellings	1,059.06	0.07	0.08	70.36	80.38
150	Letting of dwellings, including imputed rent	0.00	0.00	0.00	0.00	0.00
151	Real estate agencies or activities on a fee or contract basis	0.00	0.00	0.00	0.00	0.00
152	Renting of cars and other transport equipment	476.71	0.15	0.17	71.63	80.53
153	Renting of machinery and equipment, excl. office machinery and computers	330.13	0.15	0.17	50.60	56.87
154	Renting of office machinery and equipment including computers	32.72	0.11	0.13	3.68	4.14
155	Renting of personal and household goods	74.25	0.12	0.14	8.98	10.08
156	Computer services and related activities	1,106.86	0.09	0.10	98.68	112.04
157	Research and development	1,279.69	0.15	0.17	189.85	219.20
158	Legal activities	1,698.90	0.06	0.07	99.31	111.41
159	Accounting, book-keeping and auditing activities; tax consultancy	310.73	0.06	0.07	20.09	22.69
160	Business and management consultancy activities; management activities; market research and public opinion polling	58.84	0.09	0.10	5.26	5.92
161	Technical consultancy; technical testing and analysis; architectural and engineering related activities	1,875.41	0.08	0.09	142.45	160.20
162	Advertising	610.43	0.12	0.14	74.17	84.41
163	Other business services	1,754.06	0.08	0.09	140.20	159.37

164	Public administration (not defence); compulsory social security	0.00	0.00	0.00	0.00	0.00
165	Public administration - defence	0.00	0.00	0.00	0.00	0.00
166	Primary, secondary and other education	31.26	0.11	0.13	3.53	4.02
167	Higher-level education	20.22	0.08	0.09	1.57	1.79
168	Human health and veterinary activities	12,050.45	0.12	0.13	1,392.31	1,603.28
169	Social work activities	1,013.09	0.13	0.16	135.61	163.77
170	Collection and treatment of sewage and liquid waste	343.38	0.22	0.50	76.87	172.85
171	Collection and treatment of solid and other waste (excl. waste incineration)	341.87	0.21	1.69	73.26	577.64
172	Waste incineration	25.05	0.22	1.69	5.50	42.30
173	Sanitation, remediation and similar activities	60.09	0.28	0.46	17.09	27.34
174	Activities of membership organisations	0.00	0.00	0.00	0.00	0.00
175	Recreational and cultural activities	146.71	0.11	0.13	15.51	18.98
176	Sporting and other activities	22.45	0.10	0.13	2.30	2.82
177	Dry cleaning, hair dressing, funeral parlours and other service activities	369.57	0.13	0.16	47.85	58.55
178	Private households as employers of domestic staff	0.00	0.00	0.00	0.00	0.00
Total from 178 sectors		**63,749.4**			**15,856.8**	**18,527.1**

Appendix 2: Travel emission estimates

In this Appendix estimates of emissions from patient, visitor and staff commuting travel are estimated. These emissions are then added to those calculated from the business/fleet/patient transport services(PTS) travel emissions which are obtained from the Input-Output model.

The main data source for estimates of distances travelled for patient/visitor/staff commuting travel is the Transport Statistics Bulletin: National Travel Survey 2006, Department for Transport. The main assumptions are:

- NHS Staff commuting – Distance and modes of travel can be taken from 'commuting' e.g in Tables 4.1/ 7.2
- Visitor/patient travel – Distance and modes of travel can be taken from 'personal business' e.g in Table 7.2. However, visitor/patient travel is a subset of 'personal business', and the further breakdown of the 'personal business' section as set out below was supplied by e-mail from the national.travelsurvey@dft.gsi.gov.uk on 02 Feb 2008

2.1. Basic NTS data - Trips and distance per person per year by purpose, 2004

Purpose:	Trips per person per year	Distance per person per year (miles)
Personal business medical	18	70
Other social [1]	16	123
Escort shopping/ pers. business	35	141

[1] Other social refers to meeting friends outside of a private home, not for food/drink.

2.2. NHS patient/visitor Travel (kms) estimated from NTS data

2004 NTS data - used for NHS travel Category	trips/yr	distance (miles)	distance (kms)	distance / trip (km)
personal business – medical [1]	16.0	62.2	99.6	6.2
other social - visit friends (i.e. in hospital) [2]	2.0	15.4	24.6	12.3
escort - passenger to hospital visit [3]	4.0	0.0	0.0	0.0
Total NHS related patient/visitor travel	**22.0**	**77.6**	**124.2**	**5.6**

[1] It is assumed that 16/18 trips per year are to NHS premises. The other 2/year are for non NHS i.e. private healthcare (eg private eye tests, private dental check up)
[2] Most trips are for visit friends - social. Thus it is assumed that 1/10th ie. 2 trips per year are for visiting friends eg. In NHS premises e.g. hospitals
[3] Most escort trips are as passengers for shopping/other activities. Thus it is assumed that 1/10th ie. 4 trips/year are visiting friends as a passenger to NHS premises e.g. Hospitals

2.3. England & UK population data

	Population (mid 2004)
England	50,093,800
United Kingdom	59,834.90

Source: Office for National Statistics

2.4. CO2 Conversion factor

Mode	Walk	Bicycle	Car driver	Car passenger	Motor-cycle	Other private	Local stage bus	Surface rail/ underground	Other public	Total
Distance travelled (miles/ thousands)	15.72	1.80	248.02	129.05	1.97	9.19	19.14	21.06	7.75	453.70
Proportion	0.03	0.00	0.55	0.28	0.00	0.02	0.04	0.05	0.02	1.00
Conversion factor	0.00	0.00	0.256*	0.29	0.23	0.23	0.26	0.07	0.72	0.25

Sources: distance travelled for personal business from NTS 2004 table 7.2

Conversion factors, which include both direct and indirect impacts, from REAP model, SEI

*This is from direct carbon conversion factor from DEFRA (0.18 kg/km) plus indirect car conversion factor from REAP SEI (0.076kg/km)

2.5. Estimation of NHS patient/visitor travel emissions (2004)

Population of England	50,093,800.00	no
NHS related travel/person	149.92	kms
total travel distance	7,510,099,440.90	kms
CO2 conversion factor	0.25	kg/km
Total CO2 emissions	1,911,574.91	Tes (CO2)

2.6. Estimation of NHS staff commuting travel emissions (2004)

Number of NHS staff	1,300,000.00	no
No of commuting trips/yr	168.00	per year
distance per person/yr	2,284.80	kms/yr
Total commute distance	2,970,240,000.00	kms/yr
CO2 conversion factor	0.25	kg/km
Total CO2 emissions	756,026.78	Tes (CO2)

2.7. Estimation of NHS patient/staff/visitor travel emissions (2004)

NHS patient/visitor distance	7,510,099,440.90	kms
NHS staff commuting distance	2,970,240,000.00	kms
TOTAL distance travelled	10,480,339,440.90	kms
NHS patient/visitor emissions	1,911,574.91	Tes (CO2)
NHS staff commuting emissions	756,026.78	Tes (CO2)
TOTAL emissions	2,667,601.69	Tes (CO2)

Appendix 3: Building emission estimates

3.1. Basic data from ERIC 2004-2005 (totals)

Utility Electricity	11,032,005.00	GJ
Utility Gas	29,132,753.00	GJ
Utility Oil	2,252,095.00	GJ
Utility Coal	1,730,794.00	GJ
Local Electricity	545,299.00	GJ
Local steam	1,775,423.00	GJ
Local hot water	625,340.00	GJ
Utility Electricity	3,064,690,989.00	kWh
Utility Gas	8,093,078,783.40	kWh
Utility Oil	625,631,991.00	kWh
Utility Coal	480,814,573.20	kWh
Local Electricity	151,484,062.20	kWh
Local steam	493,212,509.40	kWh
Local hot water	173,719,452.00	kWh

3.2. Conversion factors from DEFRA (2005)

Electricity, gas, and other fuels*	0.57	kg CO2/ kWh
Gas	0.19	kg CO2/ kWh
Oil	0.27	kg CO2/ kWh
Coal	0.32	kg CO2/ kWh
Local electricity*	0.57	kg CO2/ kWh
Local steam*	0.19	kg CO2/ kWh
Local hot water*	0.19	kg CO2/ kWh

* taken from REAP/ SEI conversion factors

3.3. Estimation of NHS building energy use emissions (2004-2005)

Utility Electricity	1,743,875,316.43	kg CO2
Utility Gas	1,537,684,968.85	kg CO2
Utility Oil	168,920,637.57	kg CO2
Utility Coal	153,860,663.42	kg CO2
Local electricity	86,197,700.80	kg CO2
Local steam	93,710,376.79	kg CO2
Local hot water	33,006,695.88	kg CO2
TOTAL	**3,817,256,359.74**	**kg CO2**
Utility Electricity	1,743,875.32	Tes CO2
Utility Gas	1,537,684.97	Tes CO2
Utility Oil	168,920.64	Tes CO2
Utility Coal	153,860.66	Tes CO2
Local electricity	86,197.70	Tes CO2
Local steam	93,710.38	Tes CO2
Local hot water	33,006.70	Tes CO2
TOTAL	**3,817,256.36**	**Tes CO2**

Appendix 4: NHS energy mix

4.1. On-site energy use proportional to gas, coal and oil

Energy type	GJ	Energy mix
Gas	29,132,753	0.88
Coal	1,730,794	0.05
Oil	2,252,095	0.07

Data from ERIC - GJ consumed 2004-05.

Appendix 5: Calculation of comparative CO2 emissions

5.1. Total CO2 emissions England/ UK (for 2001)

Total CO2 emissions England	584.21	Mt CO2
Total CO2 emissions NI	21.25	Mt CO2
Total CO2 emissions Wales	32.03	Mt CO2
Total CO2 emissions Scotland	58.77	Mt CO2
Total CO2 emissions UK	698.57	Mt CO2

5.2. Total CO2 emissions government spending England/ UK (for 2001)

Total CO2 emissions England	53.80	Mt CO2
Total CO2 emissions UK	64.01	Mt CO2

Source: Stockholm Environment Institute (2008) Resources and Energy Analysis Programme (REAP), Version 0.966
REAP data is only currently available for 2001

5.3. NHS CO2 emissions England (2004)

CO2 emissions	18,610,678.30	tCO2
CO2 emissions	18.61	Mt CO2

5.4. NHS CO2 emissions England, excluding staff/ visitor/ patient Travel emission (2004)

CO2 emissions	15,943,076.61	tCO2
CO2 emissions	15.94	Mt CO2

These emissions are assigned to households, and therefore not comparable to government spending

5.5 Comparisons CO2 emissions

(Note – 2001 emissions in Table 5a and 5b assumed to be the same in 2004, for comparative purposes)

NHS England emissions as a percentage of total England emissions	3.19%
NHS England emissions as a percentage of total NI emissions	88%
NHS England emissions as a percentage of total Wales emissions	58%
NHS England emissions as a percentage of total Scotland emissions	32%
NHS England emissions as percentage of total UK emissions	2.66%

NHS emissions (excluding travel) as a percentage of government emissions in England	29.63%
NHS emissions (excluding travel) as a percentage of UK government emissions	24.91%

Appendix C – UK Consumption emissions

For comparison to NHS England consumption emissions, a value of 699MtCO2 for UK consumption emission has been used the SEI. This value has been calculated by the SEI using their REAP software. This approach is considered valid for our comparative purposes in this report as:

1. The SEI and UK Government's calculations of UK production emissions for 2001 are within 2% of each other.
2. Consumption emissions include imports, whilst excluding exports. As the UK exports less goods and services than it imports, it seems consistent that the SEI has calculated consumption emissions which are higher than the production emissions.
3. The UK production emissions are virtually the same for the years 2001 and 2004. Thus it is reasonable to take the same UK consumption emissions value from 2001 to also be applicable for 2004.

Table C1: Consumption vs production UK CO2 emissions (includes water and air transport)

Data source	**UK Production CO2 emissions (MtCO2)**		**UK Consumption CO2 emissions (MtCO2)**
	2001	2004	2001
UK Government[1]	624.4	632.0	n/a
SEI	636.0[2]	n/a	698.6[3]

[1] Data obtained from National Environmental Accounts http://www.statistics.gov.uk/statbase/Product.asp?vlnk=9278&image.x=20&image.y=13&image=View

[2] Production emissions value calculated by the SEI using their REAP analysis model

[3] Consumption emissions value calculated by the SEI using their REAP analysis model.